# Performance of Gold Shield Stations: Analysis and Recommendations

**Prepared for:**

**California Bureau of Automotive Repair**

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# PERFORMANCE OF GOLD SHIELD STATIONS: ANALYSIS AND RECOMMENDATIONS

DRAFT FINAL REPORT
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## EXECUTIVE SUMMARY

In response to legislative changes to the California Inspection and Maintenance Program, the California Bureau of Automotive Repair implemented a two-phase "Gold Shield" program that aimed to improve consumer convenience and promote consumer acceptance of the Smog Check program. Essentially, the Gold Shield Program provides an alternative to the statutory mandate that requires mandatory Smog Check certification at Test-Only stations by allowing certification of selected vehicles at Test-and-Repair stations provided the stations meet specific performance criteria. One of the fundamental elements of the Gold Shield concept is the assumption that by developing a valid set of certification or selection criteria for Test-and-Repair stations and closely managing the conforming stations, the performance of these stations would equal the performance of Test-Only stations.

In 1997, BAR established the Gold Shield Guaranteed Repair (GSGR) program, in which Test-and-Repair stations could be designated as GSGR stations if they met specific performance criteria. GSGR stations must guarantee that vehicles will pass a Test-Only inspection for up to 10 days after repairs are performed. By providing repair guarantees to motorists, BAR hoped that GSGR stations would reduce ping-ponging between Test-Only facilities and repair shops.

GSGR stations had no specialized testing authority so they could not certify previously identified gross polluters. Since gross polluting vehicles contributed disproportionately to overall mobile sources emissions, the California Legislature mandated that gross polluters must be certified by Test-Only stations. Although gross polluters represent only 10 to 15 percent of all California vehicles, they are responsible for over 50 percent of vehicle-based emissions.

Legislators were concerned that too few Test-Only stations would be available to certify gross polluters, leading to motorist inconvenience. To address this concern, in December 1997, BAR began the second stage of the Gold Shield Program by selecting (using performance criteria) a specialized group of GSGR stations that would be able to certify gross polluters after repairs. These stations were labeled as Gross Polluter Certification (GPC) stations and were given the authority, on a pilot basis, to certify gross polluters.

In 2000, BAR started the third phase of the GSGR program by developing new station performance standards. Although no new GPC stations were added, BAR allowed GSGR stations that met the newly developed criteria to offer the repair services tied to the Consumer Assistance Program (CAP). Accordingly, these stations were labeled CAP stations. Most CAP stations cannot certify gross polluters.

Using data from BAR's roadside emission test program, Eastern Research Group (ERG) estimated the emission reductions observed for vehicles certified at different types of stations. ERG found the following:

- Vehicles certified at Test-Only stations consistently showed the greatest emission reductions of all the station types.
- Vehicles certified at GSGR stations did not show consistently greater reductions than those certified at regular Test-and-Repair stations.
- Vehicles certified at GPC stations showed greater reductions than those certified at other types of Test-and-Repair stations, but the small sample sizes make the results uncertain. Note that the small number of GPC stations are continually scrutinized by BAR; they are subject to more frequent audits and undercover surveillance activities than regular Test-and-Repair stations and standard GSGR stations. The performance of GPC pilot stations cannot be used to predict the results a full-scale GPC program.

The fact that GSGR stations do not show consistently better performance than regular Test-and Repair stations leads one to conclude that the criteria for receiving "Gold Shield" status is too lenient. In addition, the plethora of types of Smog Check stations is bound to confuse motorists. ERG recommends that BAR consolidate all the different Gold Shield stations into one category and concurrently, develop criteria that assures that Gold Shield stations perform accurate inspections and competent repairs. Preliminary criteria are proposed in this report.

BAR is now faced with the responsibility of revising the existing Gold Shield Program to allow higher performing Test-and-Repair stations to perform after-repairs certification tests on vehicles directed to Test-Only stations, a function currently reserved to licensed Test-Only stations. Consequently, with a change of this magnitude, BAR should implement a pilot program of specially authorized Test-and-Repair stations and evaluate the results thoroughly before expanding the program statewide.

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# 1.0 Introduction and Objectives

The most important elements of an inspection/maintenance (I/M) program are the identification and effective repair of vehicles with tampered, defective, or worn-out emission control systems. In order for an I/M program to achieve maximum benefits, all I/M inspection stations must perform accurate and complete emission tests before and after repairs. The performance of individual stations is a critical issue that must be addressed in a comprehensive evaluation of an I/M program. Currently, the overall performance of Test-and-Repair stations is such that the Smog Check Program is not achieving the maximum mobile source emission reductions available.

The intent of the Gold Shield Program is to identify Test-and-Repair Smog Check stations with exceptionally high performance, and to provide those stations with the additional authority to repair and certify directed vehicles that fail initial inspections at Test-Only stations. Such a program would be expected to have numerous benefits: overall Test-and-Repair station performance would improve as stations tried to achieve Gold Shield Program goals, resulting in increased emission reduction; consumers would benefit from the identification of high performing stations; and the Gold Shield stations themselves would benefit from the recognition they receive.

The Gold Shield Program would also satisfy several important external constraints:

- The ARB Smog Check Evaluation Report[1] details a shortfall in the emissions reductions specified in California's 1994 State Implementation Plan (SIP). ARB provides suggestions for improving the Smog Check Program, including sending more vehicles to Test-Only stations and/or higher performing Test-and-Repair stations.
- Existing legislation calls for the development of a voluntary certification program for Test-and-Repair stations, to increase consumer convenience (see Section 2 for additional information on historical program requirements).
- Analysis of emission reductions and pass/fail rates of different station types[2] (i.e., Test-Only, Test-and-Repair) found that while some stations perform at a high level, other stations have such low performance that the Smog Check inspections performed at their stations have no emission reduction benefit (see Section 3 for additional comparisons of results by station type)

[1] "Evaluation of California's Enhanced Vehicle Inspection and Maintenance Program (Smog Check II)," California Air Resources Board, July 12, 2000.

[2] Klausmeier, R., S. Kishan, A. Burnette, and M. Weatherby, "Smog Check Station Performance Analysis Based on Roadside Test Results," prepared for California Bureau of Automotive Repair, June 27, 2000.

- The state may be faced with third-party litigation and/or federal agency intervention if the commitments in the SIP are not met.
- BAR has been directed by the California Legislature to report on the implementation status of the Gold Shield Program.

This report is intended to be a comprehensive document on past performance and future goals for the Gold Shield Program. In Section 2, the history of the Gold Shield Program is described. The history includes the legislative actions that prompted BAR to promulgate the program in 1997, and a description of the program that has been in place since then. In Section 3, the goals of the program are described in more detail. Specifically, air quality improvement goals are discussed, as well as goals oriented toward addressing the concerns of consumers and the administrative concerns of BAR. Section 4 contains a proposal of a new method of evaluating and ranking stations for admittance to the Gold Shield Program. Finally, recommendations for the transition from the pilot Gold Shield Program to the Enhanced Gold Shield Program are outlined in Section 5.

# 2.0 History of Gold Shield Program

The history of the Gold Shield Program, including legislative requirements, implementation of the Program, and current program status, is described in this section.

## 2.1 Legislative Background

The Gold Shield concept was presented in the form of Assembly Bill 2515 (Bowler, Chapter 1088, Statutes of 1996). AB 2515 was introduced by Assemblyman Bowler to offer an alternative to consumers whose vehicles had failed a smog check inspection as a gross polluter and now had to wait two or three weeks to get a certification inspection at a referee facility. During this time, the 50 or so referee facilities located throughout the state were performing this function as there were no Test-Only facilities. The demand for gross polluter inspections easily outstripped the supply. Even though abbreviated test procedures were instituted at the referee facilities, backlogs measured in days were not uncommon. The fear was that when the Test-Only contracts were finally executed and gross polluting vehicles were required to go to Test-Only stations for certification, the same thing would occur – backlogs and inconvenience for vehicle owners.

The Gold Shield concept proposed in the bill was simple. For the operation of the pilot program, BAR would develop some criteria to select qualified stations and then allow those stations to perform the certification inspections on the gross polluting vehicles after they were repaired. These gross polluter certification provisions have never been implemented.

AB 2515's provisions went beyond pilot programs and gross polluters, however. Two other provisions of the bill called for:

- The development of criteria or standards so that selected stations could offer repair and certification services to consumers whose vehicles fail an inspection at a Test-Only facility; and,
- If BAR directed more than 15% of the fleet to Test-Only stations, the additional volume of vehicles could be tested at Gold Shield stations.

These two provisions have never been implemented.

## 2.2 BAR Implementation of AB 2515

Given this mandate, BAR promulgated regulations in 1997 that created a certification on top of the traditional Test-and-Repair license. BAR initially developed criteria for GSGR

stations. Later BAR administratively developed performance-based selection criteria for GPC and CAP stations.

### 2.1.1 Gold Shield Guaranteed Repair (GSGR) Stations

GSGR was the first phase in the Gold Shield Program. GSGR stations must guarantee the emission-related repairs to the vehicle. By guaranteeing the repairs, consumers would not be ping-ponged between the Test-Only facility and the repair station. Ping ponging is very frustrating to consumers, since they must travel back-and-forth between the Test-Only facility and the repair stations. Requirements to be a GSGR station include:

- Current ARD and Smog Check station license;
- No accusations pending;
- During last 12 months, no citation, order of suspension or probation or other disciplinary order issued against station; and,
- Provide specified guarantees to the consumer about the vehicle passing its certification inspection at a Test-Only station

GSGR stations had no specialized testing authority so they could not certify previously identified gross polluters, but it was thought that these stations would offer better repairs so that repeat visits to the referee facilities would not be necessary. When BAR personnel visited the inundated referee facilities, they discovered that many vehicles had never been repaired properly by a repair facility after their first inspection failure and were inappropriately sending consumers to the referee. However, BAR has no data on the effect of guaranteed repairs.

### 2.1.2 Gross Polluter Certification (GPC) Stations

BAR developed performance criteria for a specialized group of GSGR stations that would be able to certify gross polluters after repairs. The GPC program began on December 1, 1997. Initially, 100 stations were selected, and these stations were to be located in the Inland Empire, South Coast, San Diego, and Bay Area regions of California. These stations were selected and labeled as Gross Polluter Certification (GPC) stations. In January 1998, 14 additional stations located in other enhanced areas were added to the 100 original stations to offer more convenience to consumers. In July 1998, at the direction of the California Legislature, BAR increased the number of GPC stations to 395, including 137 in basic areas. GPC stations are authorized by a Memorandum of Understanding (MOU) with BAR which allows these stations

to certify vehicles that had been previously identified as gross polluters. At this time, MOUs with GPC stations have expired.

### 2.1.3 Consumer Assistance Program (CAP) Stations

In January 2000, BAR announced its intention to enter Phase III of the Gold Shield Program, meaning that new GPC station selection criteria would be developed so new stations could be added. Problems with the selection criteria, coupled with legal concerns about requiring GPC stations to perform state subsidized repairs, delayed implementation of Phase III. However, by the Fall of 2000, new station performance criteria were finally developed. Rather than select new GPC stations, BAR allowed GSGR stations that met the newly developed criteria to offer consumers state-subsidized repair services via BAR's Consumer Assistance Program (CAP).

The following is a list of the criteria that a potential GSGR station must meet to become a CAP station:

- The station must possess and maintain a valid Gold Shield Guaranteed Repair (GSGR) certification.
- The station's failure rate for initial tests on pre-1990, non-directed vehicles must be at least 75% of the Test-Only station failure rate for the same group of vehicles in the same geographic area.
- The station must conduct one (1) repair for every four (4) initial test failures and never have less than eight (8) repairs per quarter.
- The station cannot have received any citations over the previous one (1) year period.
- The station must not have any formal disciplinary actions (Administrative, Criminal, or Civil) filed against them within the previous three (3) year period, nor can they be serving a probationary period as a result of any of these actions.
- The station cannot have engaged in any conduct, which would be cause for discipline of the station's Automotive Repair Dealer (ARD) registration or Smog Check station license.
- The station must pass a BAR-administered Quality Assurance (QA) inspection.

### 2.1.4 Derivatives of Gold Shield

With the advent of loaded-mode testing in the enhanced areas, new and used car dealers located in basic and change-of-ownership areas created a large outcry when they discovered that they were unable to inspect and certify vehicles purchased from enhanced area dealers. In the fall of 1998, the California Legislature, deluged with complaints about this issue, considered legislation that would have repealed the enhanced Program. To fight off the threatened repeal, BAR administratively created the Gold Shield Dealer station, which is a licensed new car dealer and smog check station that can certify vehicles purchased in enhanced areas. There is no regulation or statute that supports this station category, however.

In addition, to offer consumers in rural areas more convenience, BAR administratively created the Gold Shield Change of Ownership station that would allow for the certification of enhanced area vehicles to be sold by new and used motor vehicle dealers. Again, there is no regulatory or statutory support for this type of station.

## 2.2 Specific Issues Regarding the Gold Shield Program

There are a number of important concepts that must be remembered whenever the performance of the current Gold Shield Program is used to justify an expansion of GSGR or GPC station authority.

- Number of Stations. If a full blown Gold Shield component ultimately consists of 1000 or more stations, that is dramatically different from the 100 stations originally selected for the GPC pilot and substantially different than the current GPC program that includes approximately 400 stations. Therefore, it may not be appropriate to use the GPC program as the basis for comparison. Rather, the appropriate comparison standard may be the existing Gold Shield Guaranteed Repair (GSGR) program. The GSGR program - with its approximately 2000 stations that are issued a performance-based certification from BAR, has performed at a level much less than expected. In performance audits, GSGR stations performed no better than ordinary Test-and-Repair stations in several critical categories, despite their certified status. Given this data, a strong argument could be made that the GSGR program offered consumers little value and actually increased consumer confusion.

- Oversight. The number of stations may make a tremendous difference. When the GPC pilot program started, the small number of stations made for virtually direct oversight for BAR. In many instances, BAR personnel visited these stations on occasions unrelated to enforcement such as to express the importance of their role in the smog check program, to recruit them for the Consumer Assistance Program, and other promotional reasons. As the program expanded to 350 or so stations, the

ability for oversight decreased, as did the stations' performance. Maintaining direct oversight of an increased number of selected stations may not be possible within the current budget and personnel resources. Additional funding or an increase in the certificate or licensing fees may be necessary to support the level of oversight and enforcement needed to maintain a level of station performance equal to Test-Only.

- It is important to note that Test-Only stations are licensed (which means that they only have to meet minimum regulatory non-performance standards) and do not have any additional certification requirements presently, as do the GSGR and GPC stations. Theoretically, if certification criteria were to be adopted for Test-Only stations, the performance of *certified* Test-Only stations would be even higher.

- Closed System versus Open System. Essentially, the GPC stations operated in a closed system that only allowed station entry into the program when BAR deemed it necessary or advisable. In other words, even if a station met the criteria, it could not participate in the program unless BAR was accepting new stations into the program. If the new Gold Shield is an open system that allows all stations that meet the criteria to play, stations will have the right to continuously apply for entry. Therefore, stations will have the motive to manipulate their behavior in a favorable manner to gain entry and then, once in, potentially lapse into their old behavior. This problem will be especially acute if the appropriate amount of oversight is not provided.

- Enforcement Method. In the GPC Program, the participating stations were governed by a contract, which meant that in the event the station violated an applicable statute or regulation, the right to certify gross polluters (not the station license itself) could be terminated almost immediately. The new Gold Shield Program could involve a regulation-based certification that necessarily involves a formal (although possibly streamlined) process before any adverse action can be taken. From a real world perspective, this means an interval of at least 120 to 180 days before the privilege of certifying directed vehicles is lost. Knowing of this delay, a station may rationally conclude that noncompliance is more profitable than compliance for at least a short time period.

- Test-Only Effect. For some vehicles, GPC stations function as Test-Only stations because the GPC station inspects the repairs performed at another station and in essence validate them by performing a certification inspection. For example, if a regular Test-and-Repair station was repairing a gross polluter knowing that the vehicle had to return to a GPC station for certification, the fact that some other entity had to judge their work naturally improved the quality of repairs. The validation role of the GPC station for gross polluter repair is essentially the same as the role of the Test-Only station for directed vehicle repair. If the new Gold Shield Program allows stations to certify their own repairs on vehicles that have failed a Test-Only inspection, or in the alternative, authorizes certain stations to initially inspect, repair and certify directed vehicles, there is no validating entity.

Therefore, a substantial loss of inspection and repair performance with a corresponding loss of emissions reductions could result.

- The purpose of the U. S. EPA's Test-Only requirement is based on the clear separation of test and repair so that the station performing the after-repairs test is not the same entity that performed the repairs. The after repairs test is used to determine the effectiveness of the repairs performed. Under a current industry Gold Shield Program proposal, there would be no complete separation because all vehicles failing an initial Test-Only inspection could be certified at the same Gold Shield station that performed the emissions-related repairs.

- Currently, there are eight types of private sector Smog Check stations:

  - Test-Only
  - Regular Test-and-Repair
  - GSGR with CAP services
  - GSGR without CAP services
  - GPC with CAP services
  - GPC without CAP services
  - Gold Shield Dealer station
  - Gold Shield Change of Ownership station

- When an average consumer needs a Smog Check certificate for their vehicles and is confronted with all of these station types in the marketplace, each with a separate set of services that can be provided, there can be little doubt that consumers can be easily overwhelmed. Such confusion, created by the complexity of the program, can easily turn into program noncompliance, dissatisfaction, and complaints.

# 3.0 Problem Statement -- Why Should BAR Revamp How Smog Check Stations Are Classified

BAR has concerns over how the current station classification system affects the air quality benefits of the Smog Check Program, how consumers react to the Program, and how BAR manages the Program. This section discusses these concerns.

## 3.1 Air Quality Concerns

BAR is the state agency charged with the responsibility of ensuring that the Program meets or exceeds the emission reductions standards established in the federal Clean Air Act, as amended in 1990. Consequently, the effectiveness of the Program – designed to reduce emissions from mobile sources – is of critical importance to BAR.

BAR finds a wide discrepancy in station performance; some stations do a good job inspecting and repairing vehicles while others do a poor job. This discrepancy leads to the loss of emission reduction opportunities. Emission reductions only occur when high emitting vehicles are identified and properly repaired. Fraudulent inspections and incomplete repairs do not reduce emissions. If the overall performance of all stations is less than optimal, as is the case now, the benefits of the Program are significantly compromised.

The performance of various stations can be compared using results of BAR's roadside emissions tests. These types include:

- Gross Polluter Certification (GPC)
- Gold Shield Registered (GSGR)
- Regular Test-and-Repair (REG)
- Test-Only (TO)

Following are the measures that were used to compare the performance of Smog Check stations:

- Reported failure rates for vehicles that exceed Smog Check cutpoints in roadside tests prior to their Smog Checks.
- Observed differences in roadside emission rates before and after Smog Checks.

This section provides a summary of the analysis. The data used for this analysis is discussed in Appendix A.

### 3.1.1 Smog Check Station Results on Vehicles That Exceed ASM Standards in Roadside Tests

Results of roadside tests that were performed before vehicles are given their Smog Check can help us assess the accuracy of the initial smog inspections. Of primary interest are the Smog Check results on vehicles that exceeded ASM standards during the roadside tests. Although some of these vehicles will be repaired prior to inspection, one would expect that most of the vehicles would still be in a high emissions state when they were inspected. Consequently, they should fail their initial Smog Check.

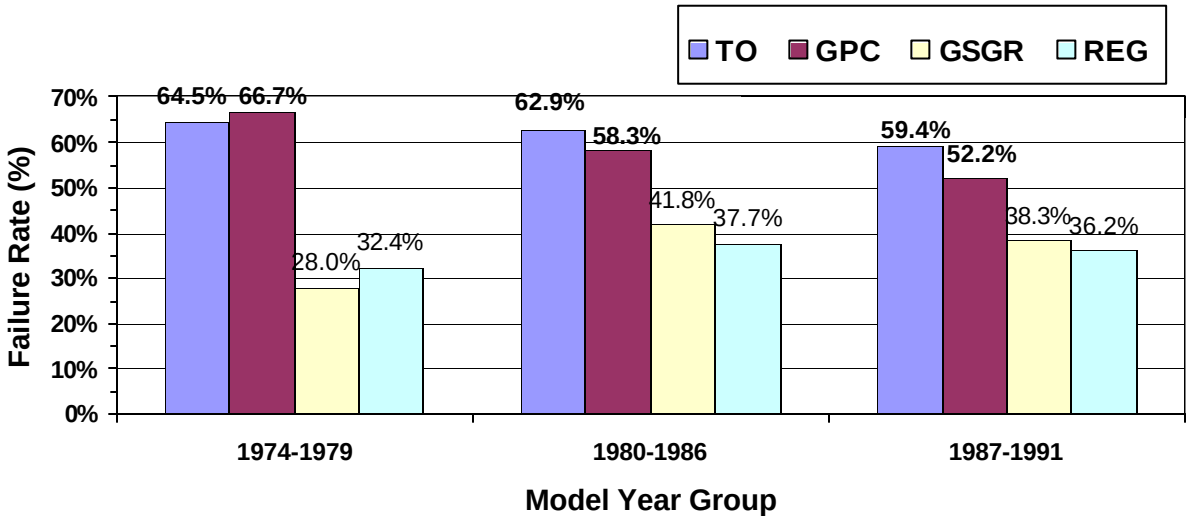
Table 3-1 compares the failure rate (tailpipe failure rate only) for the Smog Check that was performed after the roadside test on vehicles that exceeded Smog Check standards during the roadside test. The results in Table 3-1 also are shown in Figure 3-1. As shown, the failure rate was about twice as high for the TO and GPC stations than GSGR and Regular Test-and-Repair (REG) stations.

**Table 3-1. Smog Check Fail Rates for Vehicles that Failed Previous Roadside**

| Model Year Group | Station Type | | | |
|---|---|---|---|---|
| | TO | GPC | GSGR | REG |
| **1974-1979** | 64.5% | 66.7% | 28.0% | 32.4% |
| **1980-1986** | 62.9% | 58.3% | 41.8% | 37.7% |
| **1987-1991** | 59.4% | 52.2% | 38.3% | 36.2% |

*This table shows the emissions failure rate that was reported by Smog Check stations on vehicles that exceeded Smog Check standards in roadside tests that were conducted prior to the Smog Check. The higher failure rate reported by TO and GPC stations might indicate that they perform more reliable and accurate inspections than GSGR and REG stations.*

**Figure 3-1. Comparison of Fail Rates for Vehicles that Failed Previous Roadside**




*This figure shows the emissions failure rate that was reported by Smog Check stations on vehicles that exceeded Smog Check standards in roadside tests that were conducted prior to the Smog Check. The higher failure rate reported by TO and GPC stations might indicate that they perform more reliable and accurate inspections than GSGR and REG stations.*

### 3.1.2 Analysis of Roadside Emissions Before and After Smog Check

To evaluate the emission reduction performance of different station types, we used the roadside emission measurements of the vehicles as the "true" emissions values for the vehicles. The conceptual relationship between the Smog Check and roadside emissions is described in Appendix B. In all cases, the roadside measurements were performed using a full ASM test and not the short pass or short fail test that is frequently used at Smog Check stations.

We know that the vehicles tested at each of the four types of Smog Check stations are not representative of the distribution of vehicles in the fleet as a whole. This is especially the case for the Test-Only stations, since vehicle-targeting techniques are used to send expected high emitters to the Test-Only stations. Accordingly, the analysis must attempt to account for these differences in vehicle distributions among the four station types. A description of the model used to account for these differences is given in Appendix C. In this study, we will use the traditional approach of dividing each of the station types into model year groups. The three model year groups we have chosen are representative of approximate differences in light duty vehicle emission control technology. Within these groups, we calculated average ASM failure probabilities (Fprob) to determine if sampling biases exist. Distributions of overall ASM Fprobs by station type and model year group are shown in Appendix D.

To evaluate the reductions in emissions concentrations for different station types, we calculate the average roadside emissions for vehicles where the roadside emissions were measured before a Smog Check and for those vehicles where the roadside emissions were measured after a Smog Check. Then the difference between the before and after measurements becomes an estimate of the change in emissions produced by the different station types. It is important to recognize that the before averages and the after averages are made on different vehicles. Nevertheless, with a sufficiently large dataset, the emissions snapshots of individual vehicles should provide sufficient information to characterize the emissions reductions produced by different station types. Note, we did not find significant differences in the Fprobs before and after repair; the before repair sample had about the same Fprob as the after repair sample, so the observed reductions were due to Smog Check influences and not sampling biases. Table 3-2 shows the average roadside emissions before and after Smog Checks for the four station types split up by the three model year groups. For each situation, the percent reduction in emissions is calculated in the bottom third of the table.

The results indicate that vehicles certified at Test-Only stations consistently showed the greatest emission reductions of all the station types. Vehicles certified at GSGR stations did not show consistently greater reductions than those certified at regular Test-and-Repair stations. Vehicles certified at GPC stations showed greater reductions than those certified at other types of Test-and-Repair stations, but the small sample sizes make the results uncertain. The small number of GPC stations are continually scrutinized by BAR; they are subject to more frequent audits and undercover surveillance activities than regular Test-and-Repair stations and standard GSGR stations. The performance of GPC pilot stations cannot be used to predict the results of a full-scale GPC program.

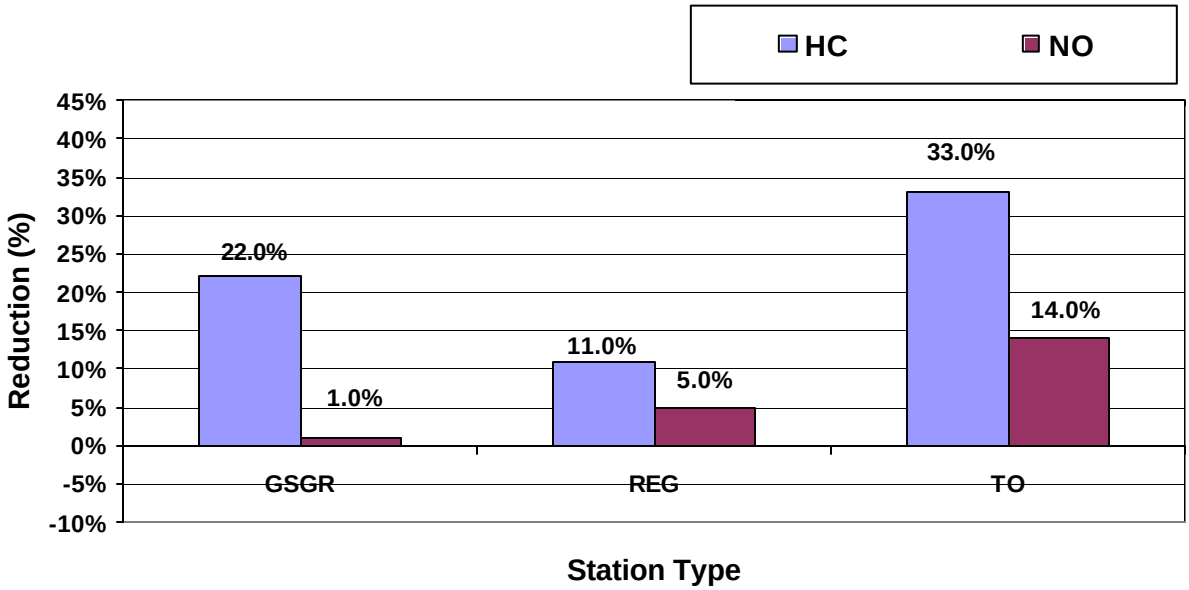
Figure 3-2 compares the observed reductions in HC and NO emissions by type of Smog Check station for the 1980 to 1986 vehicles. Vehicles within the 1980 to 1986 group are not significantly impacted by California's mandate to direct high emitters to Test-Only stations. These vehicles are as a group high emitting and thus it does not matter that a few are directed to Test-Only stations. As shown, much greater emission reductions were observed for vehicles being certified at Test-Only stations. Vehicles certified at GSGR stations do not show consistently greater reductions than those certified at regular Test-and-Repair stations. Due to small sample size, GPC stations are not included on Figure 3-2.

## Table 3-2. Average Roadside ASM Emissions by Station Type and Model Year Group

| Sequence | Station Type | Model Year Group | N | HC2525 (ppm) | CO2525 (%) | NO2525 (ppm) | Fprob Overall |
|---|---|---|---|---|---|---|---|
| Before Smog Check | GPC | 73-79 | 8 | 81 | 1.00 | 912 | 18.53 |
| | | 80-86 | 40 | 83 | 0.93 | 748 | 23.79 |
| | | 87-91 | 101 | 50 | 0.44 | 507 | 11.81 |
| | GSGR | 73-79 | 56 | 390 | 1.48 | 917 | 20.31 |
| | | 80-86 | 270 | 103 | 1.05 | 747 | 26.56 |
| | | 87-91 | 637 | 52 | 0.31 | 511 | 12.36 |
| | TO | 73-79 | 143 | 175 | 1.05 | 907 | 26.73 |
| | | 80-86 | 1010 | 105 | 0.95 | 764 | 29.19 |
| | | 87-91 | 651 | 49 | 0.33 | 488 | 15.66 |
| | REG | 73-79 | 150 | 287 | 1.62 | 935 | 22.73 |
| | | 80-86 | 747 | 113 | 1.11 | 806 | 26.75 |
| | | 87-91 | 1398 | 56 | 0.37 | 454 | 12.70 |
| After Smog Check | GPC | 73-79 | 12 | 45 | 0.59 | 634 | 18.75 |
| | | 80-86 | 51 | 61 | 0.38 | 490 | 24.87 |
| | | 87-91 | 92 | 35 | 0.17 | 323 | 12.23 |
| | GSGR | 73-79 | 67 | 222 | 1.51 | 805 | 26.07 |
| | | 80-86 | 346 | 80 | 0.62 | 742 | 25.44 |
| | | 87-91 | 617 | 42 | 0.26 | 396 | 12.60 |
| | TO | 73-79 | 105 | 103 | 0.70 | 798 | 24.70 |
| | | 80-86 | 681 | 70 | 0.60 | 658 | 30.13 |
| | | 87-91 | 389 | 40 | 0.29 | 371 | 16.33 |
| | REG | 73-79 | 174 | 206 | 1.11 | 934 | 22.38 |
| | | 80-86 | 884 | 101 | 0.89 | 766 | 27.03 |
| | | 87-91 | 1409 | 51 | 0.29 | 413 | 12.98 |
| Percent Reduction | GPC | 73-79 | . | 44 | 41 | 30 | . |
| | | 80-86 | . | 26 | 59 | 34 | . |
| | | 87-91 | . | 30 | 61 | 36 | . |
| | GSGR | 73-79 | . | 43 | -2 | 12 | . |
| | | 80-86 | . | 22 | 41 | 1 | . |
| | | 87-91 | . | 18 | 16 | 23 | . |
| | TO | 73-79 | . | 41 | 33 | 12 | . |
| | | 80-86 | . | 33 | 36 | 14 | . |
| | | 87-91 | . | 19 | 13 | 24 | . |
| | REG | 73-79 | . | 28 | 32 | 0 | . |
| | | 80-86 | . | 11 | 20 | 5 | . |
| | | 87-91 | . | 7 | 20 | 9 | . |

*This table shows average HC, CO and NO 2525 emissions before and after Smog Check for different types of stations. The largest emission reductions were observed for vehicles being certified at Test-Only stations. GPC stations also show large reductions, but the sample sizes for this group are small. Vehicles certified at GSGR stations do not show consistently greater reductions than those certified at regular Test-and-Repair stations.*

**Figure 3-2. Comparison of Observed HC and NO Emission Reductions for Different Types of Smog Check Stations – 1980 to 1986 Vehicles**




*This figure compares observed % reductions in HC and NO 2525 emissions for 1980 to 1986 vehicles certified at GSGR, Test-Only and regular Test-and-Repair stations. There were too few 1980 to 1986 vehicles that were certified at GPC stations to include them in the comparison. The largest emission reductions were observed for vehicles being certified at Test-Only stations. Vehicles certified at GSGR stations do not show consistently greater reductions than those certified at regular Test-and-Repair stations.*

### 3.1.3 Ranking the Performance of Individual Stations

For an I/M program to achieve maximum benefits, all stations must perform accurate and complete emission tests before and after repairs. Based on the analysis presented in earlier sections, vehicles certified at the pilot GPC facilities and Test-Only facilities have lower after Smog Check emission levels than vehicles certified at GSGR and Regular Test-and-Repair facilities. dKC and ERG investigated the performance of the different types of Test-and-Repair stations with the goal of identifying characteristics of high performing stations. These characteristics could then be incorporated into performance standards for future GPC stations.

Performance standards to rank all Test-and-Repair stations (GPC, GSGR, and Regular Test-and-Repair) were calculated using data stored in BAR's Vehicle Information Database (VID), a database containing all Smog Check results. The standards were evaluated using data

collected from roadside tests performed between February 1997 and December 2000 (Appendix A). ERG ranked the different Test-and-Repair stations using the procedure presented below.

The ERG rankings are based on the actual failure rate at a station compared with the expected failure rate. Data from BAR's Vehicle Information Database (VID) were used to calculate expected and reported failure rates. The expected failure rate at a station is based on the average failure probability of the set of vehicles that were tested at the station. The difference between the actual and expected failure rate is used to develop the final rankings. The standard error of the expected failure rate is also considered in determining these rankings. The difference between the actual and expected failure rates is divided by the standard error of the expected failure rate to determine how the station's actual failure rate compares to the expected failure rate. The following equation is used to calculate the number of standard deviations between the actual and expected failure probabilities.

$$N_s = \frac{(F_p - FR)}{Std\ Err}$$

$F_p$ = Average expected Fail Rate at Station
FR = Actual Fail Rate at Station
Std Err = Standard Error of the Expected Fail Rate at Station

$N_\sigma$ is used to rank the station from the lowest value to the highest. Stations at the top of the list report failure rates that exceed the expected failure rates. Their $N_\sigma$ values are negative. Stations at the bottom of the list report failure rates that are much lower than expected failure rates. Their $N_\sigma$ values are positive.

The fleet was broken down into 2 categories from top to bottom ranks based on $N_\sigma$:

- 0 to 50% of all stations -- The highest ranked stations.
- 75 to 100% of all stations – The bottom ranked stations.

Table 3-3 compares emissions before and after Smog Check for vehicles certified by Test-Only stations and different ranks of Test-and-Repair stations. Vehicles certified at the top 50% of Test-and-Repair stations show much greater reductions than those certified at the bottom 25%.

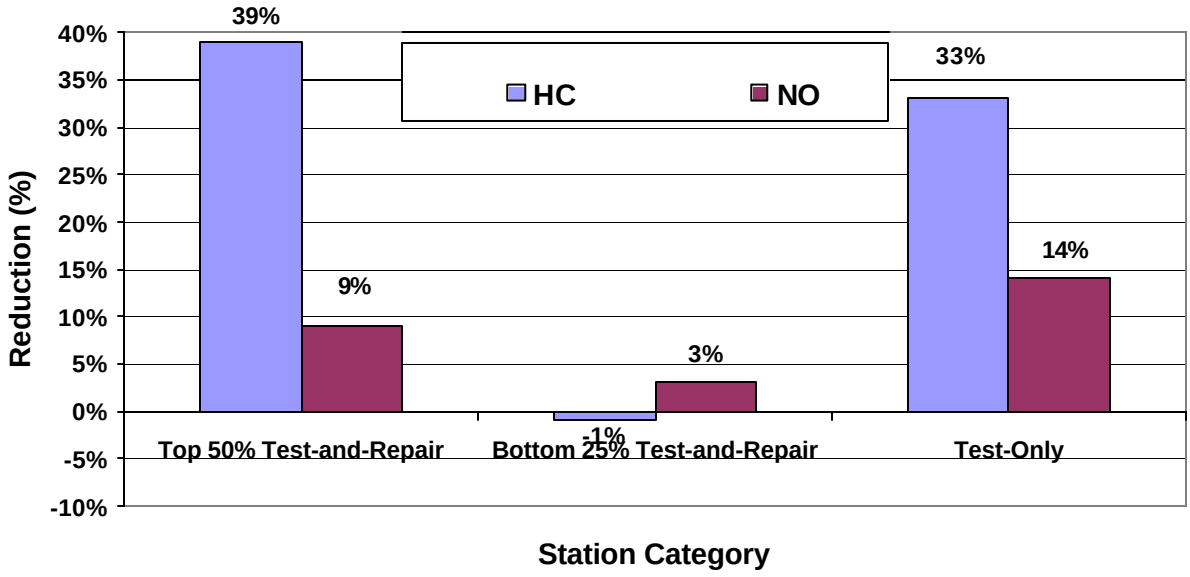
**Table 3-3. Average Roadside ASM Emissions for Non-Test-Only Stations by Station Performance and Model Year Group**

| Sequence | Station Performance | Model Year Group | N | HC2525 (ppm) | CO2525 (%) | NO2525 (ppm) | Fprob Overall |
|---|---|---|---|---|---|---|---|
| Before Smog Check | Bottom25 | 80-86 | 443 | 108 | 1.16 | 814 | 26.68 |
| | | 87-91 | 849 | 54 | 0.39 | 462 | 13.27 |
| | Top50 | 80-86 | 394 | 116 | 1.03 | 757 | 26.72 |
| | | 87-91 | 840 | 55 | 0.35 | 487 | 12.24 |
| | TO | 80-86 | 1010 | 105 | 0.95 | 764 | 29.19 |
| | | 87-91 | 651 | 49 | 0.33 | 488 | 15.66 |
| After Smog Check | Bottom25 | 80-86 | 546 | 110 | 0.96 | 788 | 26.56 |
| | | 87-91 | 817 | 61 | 0.35 | 478 | 13.72 |
| | Top50 | 80-86 | 414 | 71 | 0.70 | 688 | 26.16 |
| | | 87-91 | 738 | 42 | 0.25 | 349 | 12.29 |
| | TO | 80-86 | 681 | 70 | 0.60 | 658 | 30.13 |
| | | 87-91 | 389 | 40 | 0.29 | 371 | 16.33 |
| Percent Reduction | Bottom25 | 80-86 | . | -1 | 18 | 3 | . |
| | | 87-91 | . | -14 | 10 | -3 | . |
| | Top50 | 80-86 | . | 39 | 33 | 9 | . |
| | | 87-91 | . | 23 | 27 | 28 | . |
| | TO | 80-86 | . | 33 | 36 | 14 | . |
| | | 87-91 | . | 19 | 13 | 24 | . |

*This table shows average ASM 2525 emissions before and after Smog Check for the groups of ranked Test-and-Repair station compared to Test-Only (TO) stations. The highest ranked groups had the greatest HC and NO emission reductions. The reductions for the top 50% are similar to Test-Only.*

Figure 3-3 compare reductions in Smog Check HC and NOx levels for ranked Test-and-Repair stations with Test-Only stations. Again, the dataset is limited to 1980 to 1986 model year vehicles to minimize concerns over sampling biases due to high emitters being directed to Test-Only facilities. Much greater emission reductions were observed for vehicles being certified at the top 50% of Test-and-Repair stations. The top 50% had observed reductions of 39% and 9% compared to almost no reductions for the bottom 25%. The reductions for the top 50% are similar to Test-Only.

**Figure 3-3. Comparison of Observed HC and NO Emission Reductions for Test-and-Repair Stations (1980 to 1986 Model Year Vehicles)**




*This figure compares observed reductions in HC and NO 2525 emissions for the groups of ranked Test-and-Repair stations. The highest ranked groups had the greatest HC and NO emission reductions. The top 50% had observed reductions of 39% and 9% compared to almost no reductions for the bottom 25%. The reductions for the top 50% are similar to Test-Only.*

### 3.1.4 Conclusions

The performance of GSGR stations is not much different than regular Test-and-Repair stations. The current criteria for becoming a GSGR station is not stringent enough to keep poor performing stations from participating. There is little evidence to support the concept that GSGR stations are offering consumers any additional value.

Vehicles certified at the top 50% of Test-and-Repair stations were observed to have much greater HC and NO emissions reductions than those certified in the bottom 25% of Test-and-Repair stations. Having a large variation in station performance allows motorists that want to avoid repairs to seek out poor performing stations. Stations with Gold Shield status should, at a minimum, have performance equal to the top 50% of the Test-and-Repair stations. Stations in the bottom 25% should not be allowed to perform any Smog Check inspections or repairs.

Vehicles certified at Test-Only stations consistently showed the greatest emission reductions of all the station types. Note that no attempt has been made in this report to identify good vs. bad performing Test-Only stations. It is likely that measures intended to increase the effectiveness of Test-and-Repair stations, such as certification, also would improve the performance of Test-Only stations.

## 3.2 Consumer Concerns

The consumer expectations for the Gold Shield Program could also be described as the "layman's desires." The consumers are not generally concerned with the technical details of the inspection and repair process, but rather with their interaction with the station and its personnel, their confidence in the inspection and repair diagnosis provided by the station, and the help they are given in understanding I/M requirements. Consumer expectations would include:

- Provide a wide array of services, including state subsidized repair services.
- Accurately explain the consumer's rights, requirements and obligations under the I/M program in a courteous manner, including the options of consumer assistance programs and repair cost waivers.
- Accurately diagnose the reason for the test failure using the appropriate diagnostic methods and make ethical recommendations of the repairs needed to consumers, including those repairs that will bring the vehicle's emissions down to below the cutpoints, as compared to those repairs that will reduce the emissions to a level which indicates the vehicle is in proper operating condition.
  - Stations will get the diagnosis and repair right the first time such that repeated diagnoses and repairs that lead to increased consumers costs are not necessary.
  - The prices charged will be fair and reasonable.
  - The authorized repairs will be performed in accordance with accepted trade standards and vehicle manufacturer procedures.
- Stations meet or exceed the Gold Shield standards set by the state and those stations that do not meet the standards are not allowed to display the Gold Shield.
- That a station is accurately "branded" so that it is readily apparent what stations can offer what services because most consumers assume any BAR-licensed Smog Check station can inspect and certify their vehicle, irrespective of any special Smog Check Program requirements.

## 3.3 BAR Concerns

BAR is the entity responsible for oversight of the Gold Shield Program, so many of BAR's concerns about the Program are related to administration, oversight and enforcement:

- A large number of different types of stations make program compliance confusing and difficult to explain to consumers.
- The original GSGR Program, which had wide open entry standards, does not offer consumers much value and may even be misleading since there are no standards that indicate the station has demonstrated any specialized knowledge or competence.
- As mentioned earlier, the GPC pilot program is now operating on expired MOUs and has been in existence statewide for over three years. This is longer than a traditional pilot program, and it is suggested that the GPC pilot program is brought to a close and the findings formalized.
- The requirements for Gold Shield Stations need to be well defined, so that the entrance/exit methodology is defensible, consistent, and easy to explain to consumers and stations.
- The Gold Shield Program must be manageable in scope and oversight such that the deterrence and enforcement effects are strong and palpable.
- Consumer protection is one of the most critical elements of the Gold Shield Program. Consumers and BAR must have confidence that stations are providing honest inspections and repairs.

In addition, BAR has specific expectations of the performance of Test-and-Repair stations that are admitted to the Gold Shield Program:

- Obey all applicable statutes, rules, regulations, and contractual obligations that govern the operation of a Test-and-Repair station, an automotive repair dealer, and a Consumer Assistance Program station.
- Enter all appropriate inspection and repair information, including price information, in the emissions analyzer.
- Accurately diagnose the reason for the test failure using the appropriate diagnostic methods and make ethical recommendations of the repairs needed to consumers, including those repairs that will bring the vehicle's emissions down to below the cutpoints and those repairs that will reduce the emissions to a level which indicates the vehicle is in proper operating condition.

  - Stations will get the diagnosis and repair right the first time such that repeated diagnoses and repairs that lead to increased consumers costs are not necessary.
  - The prices charged will be fair and reasonable.
  - Perform the authorized repairs in accordance with accepted trade standards and vehicle's manufacturer procedures.
- Consistently meet or exceed the Gold Shield standards adopted by the BAR.
- Adopt internal quality assurance plans and procedures to ensure consistent and accurate inspections and repairs.
- Explain the consumer's obligations, rights, and requirements in regards to the I/M program.
- Support the emissions reduction goals of the I/M Program.

Since BAR is also a consumer protection agency, many of the consumer's expectations are similar to BAR's. This overlap is indicative of BAR's commitment to the improving the effectiveness of the Program without any loss of consumer protection in the Test-and-Repair marketplace.

# 4.0 Enhanced Gold Shield Designation Process

Data from BAR's roadside test program indicate that current Gold Shield Guaranteed Repair (GSGR) stations do not provide the superior performance expected by BAR or consumers. In addition, the proliferation of types of Smog Check stations only confuses motorists. BAR's goal would be much better served by establishing only three types of Smog Check stations: Test-Only, Test-and-Repair, and Gold Shield Test-and-Repair. This section presents new criteria to become a designated Gold Shield station. In addition, on-going performance criteria that all stations must meet is discussed.

A two-part process is being proposed to obtain and maintain Gold Shield status:

- Stations must meet minimum service and performance requirements to be designated as a Gold Shield station;
- Stations must meet on-going performance standards that are more stringent than regular Test-and-Repair stations to maintain Gold Shield status.

Details on how to be designated as a Gold Shield station are presented in this section 4.1. Section 4.2 discusses performance standards that must be met to maintain Gold Shield status.

## 4.1 How Stations Become Eligible for Gold Shield

To be eligible for Gold Shield status, a Smog Check station must meet minimum requirements. These requirements are described in the following subsections:

- Section 4.1.1: Services Offered by Station
- Section 4.1.2: Clean Record for Disciplinary Items
- Section 4.1.3: Good Performance Based on BAR Administered Quality Assurance Checks
- Section 4.1.4: Commitment to Good Repair Diagnosis and Performance
- Section 4.1.5: Station-Consumer Interface
- Section 4.1.6: Adequate Internal Quality Assurance Procedures

In each of the subsections, a method for rating the station's success on each requirement is proposed. If a station initially meets these requirements, but later is found out-of-compliance, e.g. an employee receives a citation after the station has received Gold Shield status, the station

immediately loses its Gold Shield status. It should be noted that these are just suggestions, and refinement or modification as planning progresses is anticipated.

### 4.1.1 Services Offered by Station

One of the goals of the revised Gold Shield Program is to reduce the complexity of I/M program compliance. All Gold Shield stations should offer a specified set of services. This will minimize the variation among stations that tends to confuse customers. Thus, on an application for Gold Shield status, the station must demonstrate the capacity to provide the following services:

- Provide regular Test-and-Repair inspections and repairs
- Certify gross polluters
- Certify directed vehicles (HEP or random) that initially fail at a Test-Only station if the vehicles are repaired at that station, unless the station is located in a program area that is not subject to the Test-Only component of the Smog Check Program
- Provide state subsidized repair assistance under the Consumer Assistance Program

Any station that is not prepared to offer all of these services to consumers would not be eligible for Gold Shield status.

### 4.1.2 Clean Record for Disciplinary Items

The high-quality stations included in the Gold Shield Program, and the technicians employed therein, should not have any of the following disciplinary actions taken against them:

- The station and technicians employed therein must not have received any citations over the previous one-year period.
- The station and technicians employed therein must not have any formal disciplinary actions (Administrative, Criminal, or Civil) filed against them within the previous three-year period, and shall hold full and unrestricted licenses/registrations.
- The station and technicians employed therein cannot have engaged in any conduct which would be cause for discipline of the station's Automotive Repair Dealer (ARD) registration or Smog Check station license.

If any disciplinary actions are on the station record, the station would not be eligible for Gold Shield status. Also, if any of these actions are taken against a current Gold Shield station, such action would be considered grounds for immediate termination of the station's Gold Shield contract.

### 4.1.3 Good Performance Based on BAR Administered Quality Assurance Checks

The station must have received a score as specified below on its latest BAR-administered Quality Assurance (QA) inspection to be considered for Gold Shield status. Any additional QA inspections after admittance to the Gold Shield Program would also have to be passed to maintain Gold Shield status.

BAR Quality Assurance procedures dictate that each station must be inspected at least twice per year, with one follow-up inspection performed as necessary. If the station is not in compliance with all laws and regulations on an initial QA inspection, the follow-up is used to determine whether compliance has been attained. Results of the initial inspection are used for Gold Shield eligibility, since they provide the best indication of the typical performance of the station.

The goal of the QA inspection is to determine the competency of all licensed Smog Check stations and licensed technicians to perform both accurate tests and quality repairs on vehicles subject to the Smog Program. QA audits aim to achieve the following:

- Ensure the accuracy of the Emission Inspections System (EIS) and Test Analyzer System (TAS) machines.
- Ensure that all licensed Smog Check stations maintain the required testing, diagnosis and repair equipment as required by law.
- Ensure that proper testing and repair procedures are used for all consumer vehicles subject to the Smog Check program.
- Increase the level of technician competency in diagnosing and repairing emission failures.
- Ensure that all consumers are treated fairly and receive the services they have contracted and paid for.

Detailed procedures have been developed by BAR for the performance of QA inspections, to accomplish the above goals. After a QA inspection, an inspection report is filed by the BAR inspector, who fills out a standardized list of any deficiencies that were found at the

station. Twenty-four different types of station deficiencies may be found, ranging from minor infractions such as proper signs, invoices and receipts, to major infractions such as gas audit failures and diagnostic or repair problems.

Gold Shield stations must hire and retain highly capable technicians. The performance of each technician is evaluated during BAR-administered QA inspections, through which the relative skill levels of technicians may be identified. The ten QA items that apply to technicians may be used to generate a score for each technician each time a station is audited.

The assigned level of severity on each of the possible deficiencies allows the different deficiency types to be weighted and collapsed into a single score. The station must meet or exceed a minimum score to be eligible for Gold Shield certification.

### 4.1.4 Commitment to Good Repair Diagnosis and Performance

The station must commit to accurately record information on vehicle repairs in the Test Analyzer System (TAS) or Emissions Inspection System (EIS). In addition, the station must perform enough repairs that a record of good performance may be established. Following are set requirements related to repair performance.

**Compliance with Regulations** -- As a minimum requirement, the station must repair vehicles in accordance with Section 9884.7 of the Business and Professions Code and subdivision (d) of Section 3340.41 of Title 16 of the California Code of Regulations. Failure to follow the requirements in the Code of Regulations eliminates the station from Gold Shield eligibility. These statutory and regulatory sections establish the standards for good and workman like repairs that are performed in accordance with the vehicle manufacturer's recommended procedures or the procedures found in the repair manuals published by nationally recognized information providers.

**Minimum Number of Repairs Performed** -- The station must conduct one repair for every four initial test failures and never have less than eight repairs per quarter. Fewer repairs may indicate a lack of consumer confidence in the station, and prevents the station from establishing a credible record of repair performance. Therefore, this is a critical performance factor, and failure to perform enough repairs will eliminate the station from Gold Shield eligibility.

**Repair Reporting --** Tracking the type and extent of repairs is a key component of an I/M program. The station must agree to enter repair data into the emissions analyzer whenever a retest is performed, if repairs were performed at that station.

The failure to meet these commitments would render a station ineligible for participation in the Gold Shield Program.

### 4.1.5 Station-Consumer Interface

The requirements in this subsection all relate to the interaction of the consumers with the station. In general, the station should appear professional, competent, and friendly to consumers. The following performance factors address these goals.

**Consumer Feedback --** Comment cards at visible locations within the station should be available to customers wishing to give input on service received at the station.

Periodic BAR-administered surveys should be conducted to obtain more detailed feedback from consumers after receiving service by the station. As with other Gold Shield requirements, details on the survey, including the frequency will be developed later.

**Station Appearance --** Consumer comfort and confidence in the station are directly affected by the physical appearance of the station. The following factors relating to the station appearance would be used as non-critical performance factors.

- Signage. This includes exterior signs that inform consumers of the types of services performed by the station; interior signs with more detailed information on procedures, requirements, and costs; and the station's website, if it has one. Measures for judging signage would include clarity, visibility, and professionalism.
- Cleanliness and Maintenance. Outside areas, the consumer waiting room, the registration/payment desk, and the restrooms would be included in the list of areas to check for cleanliness and good maintenance.
- Americans with Disabilities Act (ADA) compliance. Each Gold Shield station should be compliant with the applicable ADA requirements.

**Personnel-Consumer Interactions --** Personnel must be capable of explaining all program requirements in a straightforward manner that consumers understand. Personnel must be able to explain emissions test results, repair diagnoses, and repair results to consumers.

Repair Guarantees -- Consumers need to be able to trust the repair work done by the stations. Before any repair work is done, cost estimates for repairs should be given in writing. A procedure for informing the customer or getting permission for any deviation from the estimate should be developed, made available to the customer, and followed. Time estimates should also be given, and the customer should be informed of any need for deviations. Finally, a detailed invoice for all work performed must be provided to each consumer, as required by existing law.

### 4.1.6 Adequate Internal Quality Assurance Procedures

In addition to the QA inspections performed by BAR, the station must also have an operative, internal quality assurance plan, which includes the review of inspection and repair data, as approved by BAR. The station's adherence to the plan will be reviewed during QA inspections. If a current Gold Shield station is found to be out of compliance with its internal quality assurance plan, then the station should immediately loses its Gold Shield status.

## 4.2 On-Going Performance Evaluation

All stations should be subjected to an on-going performance analysis. The top 1200 Test-and-Repair stations will be allowed to retain Gold Shield status. At the other end of the scale, enforcement activities, including the possible revocation of the station's license, should be pursued against stations failing to meet minimum standards. This section discusses performance factors that may be used to determine whether stations correctly identify passing and failing vehicles, and accurately enter the data in the Vehicle Information Database (VID), the computer system that links all Smog Check stations to BAR.

If any Gold Shield station moves out of the top 1200 stations by receiving low scores on station performance factors and therefore a low ranking, then that station should immediately lose its Gold Shield status at the end of the current quarter. The station must then achieve a qualifying ranking for four consecutive quarters before re-applying for Gold Shield status. The requirement that the qualifying ranking be achieved for four consecutive quarters prior to re-application to the program adds stability to the program. High quality stations should demonstrate their quality consistently. Consumers will have more confidence in the program if stations do not repeatedly lose and regain the Gold Shield certification. The goal of reduced program complexity and increased consumer acceptance will not be achieved if stations are in the program one day but not the next.

A weighting system will be used to emphasize some of the factors over others, and the weighted results will be used to rank the stations relative to each other. A method for collapsing the set of performance factor results into a single score for the rankings follows.

First, the type of result that each performance factor may yield needs to be defined. Some of the performance factors provide a binary result (i.e., the station either exceeds a given standard or it does not) while some of the factors provide a continuous results (a range of values, such as the percent fail rate at a station). Standardization of the possible results is necessary so that all of the performance factors yield uniform results, prior to being weighted for importance. This may be accomplished with a "points" system. For the binary performance factors, the station simply receives 10 points for a passing result, and zero points for a failing result.

For the continuous performance factors, the station receives a number of points from zero to 10 (the number of points does not necessarily need to be an integer). This will mean that many of the results will need to be scaled such that the range of results lies between zero and 10. In some cases, this will simply involve finding the lowest and the highest result out of the group of stations, assigning zero and 10 points for these results, respectively, and then scaling all of the results in between. Alternatively, minimum and maximum levels of performance for a factor may be set at a certain level. Stations at or below the minimum would receive zero points, while stations at or above the maximum level would receive 10 points. Intermediate results would be scaled to range from zero to 10.

Some of the continuous performance factors are more difficult to scale since results that are either too high or too low may indicate poor performance. A good example is the fail rate for initial inspections at a given station. When compared to an expected fail rate, the station should lose points for an actual fail rate that is either much higher or much lower. This situation is illustrated in Figure 4-1. Most of the stations have an actual fail rate that is very close to the expected fail rate, so most of the data points lie on or near the one-to-one line. Farther from the one-to-one line, the number of data points drops off. Stations with an actual fail rate that is close to the expected fail rate are those that lie between the lines labeled A and B in the figure. These stations would receive the full credit of 10 points on this performance factor. Stations with an actual fail rate that is excessively different from the expected fail rate are found outside the lines C and D and would receive no credit for this performance factor. Stations between lines A and C would receive partial credit, depending on their distance from line A and scaled by the distance from line A to line C. Credit for vehicles between lines B and D would be calculated similarly.

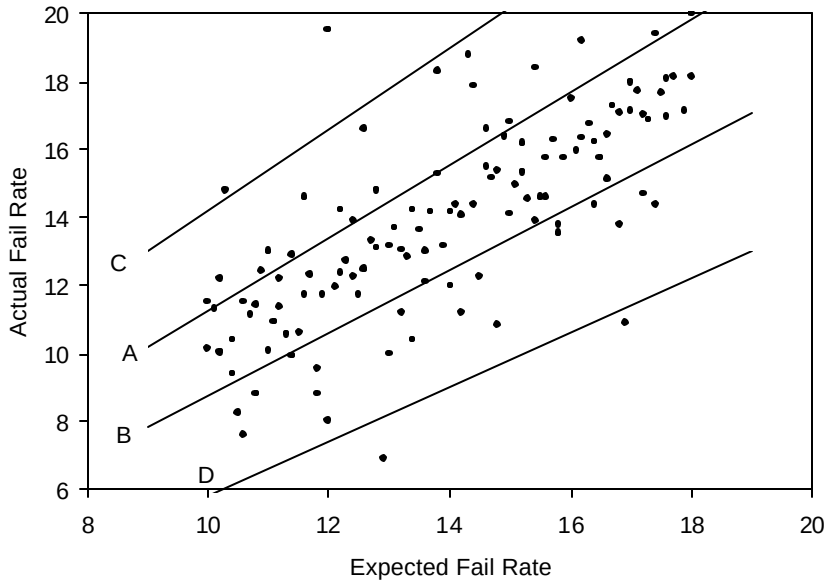



**Figure 4-1. Allocation of Credit for Continuous Performance Factor**

After the appropriate number of points are allocated for each performance factor, a weighting factor is applied to each of them. For each station, the weighted results for all of the performance factors are added up to obtain a final score. The stations are then ranked according to their final score. Actual weighting factors will be developed later. Following is a review of possible performance factors that could be used by BAR to rank the performance of individual Smog Check stations. Each factor is discussed below.

### 4.2.1 Failure Rate

An overly high or low fail rate for initial tests at a given station probably indicates that the station is conducting tests improperly. The fail rate at all stations may be compared to identify stations that are significantly different from the average. However, different stations see different vehicle mixes, and this would have to be accounted for in the comparison. A better approach would be to use the High Emitter Profile (HEP) model to calculate the failure probability (Fprob) for each vehicle tested by a given station, to develop an overall Station Failure Probability (SFP). The SFP could then be compared to the actual fail rate at the station. Slight differences between the SFP and the actual fail rate would be expected, but larger differences would be cause for concern.

### 4.2.2 Instrument Calibration

Records of I/M program analyzer calibrations can be used to measure the drift of analyzers between calibrations. If many analyzers in a state's I/M program drift substantially, the results of measurements are suspect. Ideally, all analyzers should drift no more than the specification of the analyzers. Before calibration, each analyzer is checked for drift by measuring the calibration gas mixture, whose concentration is known within a specified precision. If the analyzer has not drifted since the last calibration, its readings for the calibration gas will be close to the bottle label value, and little calibration adjustment will be necessary. The difference between this pre-calibration analyzer reading and the label concentration in the gas mixture is a direct measure of instrument drift. This fact may be used to develop an indicator of analyzer calibration stability. Analyzers that consistently drift little from calibration to calibration can be expected to produce more accurate measures of vehicle emissions than those that drift greatly. Thus pre-calibration results may be used as a non-critical performance factor for ranking the stations.

Figure 4-2 shows an example of BAR90 analyzer drift characteristics. This example shows the analyzer readings for high-span CO gas, with a labeled concentration of 4%. The analyzers have an accuracy specification of ±0.15 % CO between about 3.85% and 4.15 % for a 4% CO gas. Accordingly, we would expect that most of the pre-calibrations should fall within about ±0.15 % of 4.00%. Any pre-calibrations that fall greatly outside this range would cause concern. In the example of Figure 4-2, about 86% of the values are within ±0.15 % of 4.00%. However, 3.7% of the values are zero, and 0.5% of the values are between 0.1% and 3.5%. These unexpected values raise concern and should be investigated. High caliber I/M inspection stations would be expected to notice excessive drift and take steps to correct the problem. For each station in a given quarter, the total number of occurrences of pre-calibration data falling outside the instrument specifications should be tallied. The highest and lowest number of occurrences may be used to normalize the range of results to obtain a result between zero and 10 that may be used in the station rankings.

This measure will be weighted less than measures that directly evaluate inspector performance.

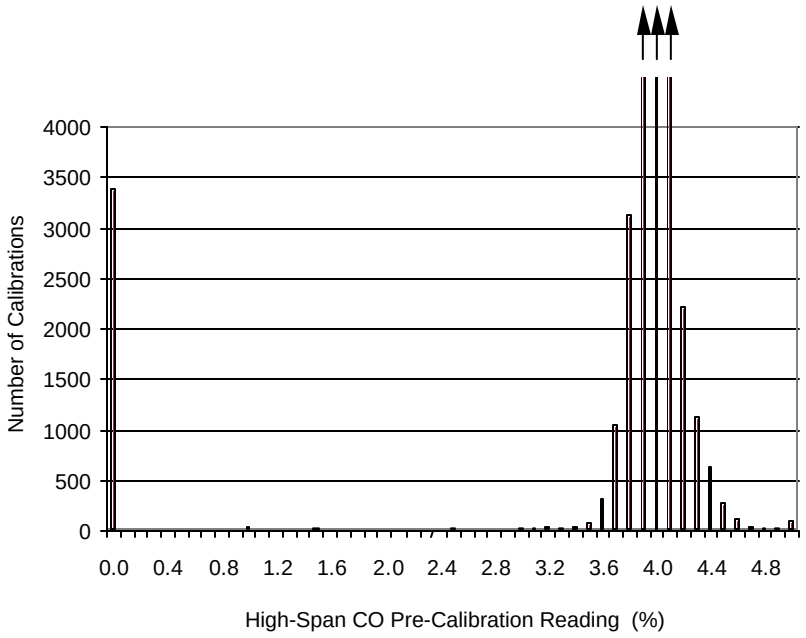



**Figure 4-2. Distribution of Values for High-Span CO Pre-Calibrations**

### 4.2.3 VID Data Entry

The accurate entry of data into the VID is a critical component of any emissions inspection, since incorrect or incomplete data severely limits the analysis that can be performed. Entries for each vehicle must be complete, unambiguous, and accurate, including:

- Recorded VINs and license plate numbers are entered and are valid. The VIN accuracy may be checked with VIN Decoding software. The plates may be checked by matching to the state registration database. Each plate should match to only one VIN, and vice-versa.
- Reasons for any aborted tests are recorded in the analyzer (if possible) and on the consumer's invoice.
- Complete repair descriptions and cost data must be recorded.

The rate at which each station successfully enters all of the above data into the VID can be scaled and used as a performance factor.

### 4.2.4 Retest Audits

BAR could use the VID to prohibit a sample of CAP vehicles repaired at the station from receiving certification at that station. Instead, these vehicles will be required to go to a Referee

station or a Test-Only station for retests. This measure will allow BAR to check the quality of repairs and independently determine the results of retests.

### 4.2.5 Summary of Performance Factors

Numerous performance factors that could be used to rank Smog Check stations were described in this section. These performance factors are summarized in Table 4-2. As a starting point for weighting the different performance factors when the ranking is done, a weight factor of low, medium, or high is suggested for each of the performance factors. Some of the performance factors provide a discrete binary result (i.e., the station either exceeds a given standard or it does not) while some of the factors provide a continuous results (a range of values, such as the percent fail rate at a station).

**Table 4-2. Summary of Performance Factors**

| Performance Factor | Suggested Weight | Continuous/ Discrete |
|---|---|---|
| Comparison of actual to predicted failure rate | High | Continuous |
| Degree of drift between instrument calibrations | Low | Continuous |
| VID data entry | High | Continuous |
| Complete reporting of repairs | High | Continuous |
| Repair cost near the mean repair cost | Medium | Continuous |

# 5.0 Recommendations for Transition to Enhanced Gold Shield Program

In Section 3, the performance of the stations in the existing Gold Shield Program was described. It was found that Test-and-Repair inspections by GSGR stations do not result in significant emission level reductions. The stations in the GPC program performed somewhat better than the GSGR stations, but still not as well as Test-Only stations. Therefore, it is recommended that the GSGR and GPC programs be terminated (and the operative regulations allowed to sunset).

To reduce consumer confusion and program complexity, and promote compliance with Smog Check requirements, the GSGR and GPC programs should be replaced with a single program that designates specialized Test-and-Repair stations that can offer many services. The stations admitted to this program should meet a strict set of criteria designed to ensure that only the highest performing Test-and-Repair stations are included in the program. The highest performing stations that are admitted to the program should be clearly labeled so that they may be identified easily by consumers.

The program should be operated by contract, to facilitate swift and consistent enforcement against any stations that violate the requirements of the program. The rights and responsibilities of stations in the program must be clear and comprehensible. This will promote confidence within the inspection station industry and avoid confusion to consumers.

BAR should establish an *advisory-only* committee consisting of high-performing technicians, scientific and technical experts (but not special interests), and other interested parties, to determine effective criteria and weights to use for ranking stations. This committee should not have the power to adjudicate complaints or adverse actions brought against a Gold Shield station.

All interested parties should have the opportunity to comment on the station admittance criteria for the enhanced Gold Shield Program, and the relevant criteria should be finalized in an open and formal process, similar to the regulatory process. The Gold Shield Program will offer, through periodic reports, feedback to stations, and BAR will make the data available so that stations have the opportunity to rate themselves and monitor their own performance.

In Section 4, a set of criteria, or performance factors, for identifying high-performing stations was developed, and a method for ranking the stations was suggested. These

performance factors could be used as a starting point for the advisory committee to work from in developing the final standards for stations in the Gold Shield Program.

Finally, BAR should adopt a plan for the transition away from the old Gold Shield Program, and the implementation of the Enhanced Gold Shield Program. Given that the new qualification and performance criteria should be decided by a cooperative effort between BAR and industry and then adopted by regulation, a strategy that combines specific short-term implementation objectives with long-term goals would be most practicable.

The following strategy is suggested:

Short Term Strategy:

- To meet tight timeframes, immediately and administratively grant certification authority for directed vehicles to existing CAP stations since CAP stations are required to meet the most stringent performance criteria.
- Modify existing CAP contracts to include this new authority.
- Modify the VID to accommodate the new testing authority of CAP stations.
- Rapidly develop the necessary public (both internal and external) awareness campaigns to inform consumers of this Program option.
- Modify CAP procedures such that some directed vehicles that receive state subsidized repairs have their final certification inspection performed at the referee or other designated Test-Only facility.
- Hold a series of public workshops to ascertain industry concerns about the selection criteria proposed in this report and to gather new ideas.
- Convene the advisory committee and begin work.

Long-term Strategy:

- Promulgate regulations to 1) formally adopt the new standards and sunset the existing GSGR and GPC programs and 2) spell out the rights and responsibilities of Gold Shield stations.
- Develop the needed public education and outreach tools.
- Inform other state agencies such as the Department of Motor Vehicles of this new Program.

Given the magnitude of allowing Test-and-Repair stations to repair and certify directed vehicles, a cautious, incremental approach, coupled with a hefty amount of data and program analysis, is warranted here. For example, only after the CAP stations have been granted the testing authority and the accuracy of those repairs has been confirmed by a Test-Only inspection, should the program then be expanded. Similarly, if ongoing analysis reveals that the performance of Test-and-Repair stations participating in the Gold Shield Program is compromising the emission reductions benefits of the Smog Check Program, this new authority should be rescinded.

# Appendix A

# Data Sources

The data used for before and after emissions analysis consisted of roadside data and matching Smog Check data. The roadside data used was taken from February 1997 to December 2000. The matching Smog Check data was obtained from ASM_ASMCLOSEST.XLS file that was sent by Melinda Yang at BAR. The spreadsheet contained only the matching ASM tests that occurred within one year of the roadside test. If more than one matching ASM test was found, only the closest to the roadside date was kept. Thus, if the roadside measurement followed a series of Smog Checks for a vehicle, the last Smog Check was matched to the roadside measurement; if the roadside measurement preceded a series of Smog Checks for a vehicle, the first Smog Check was matched to the roadside measurement. This dataset of roadside and matching data has 13,433 records. This dataset was then edited to remove all roadside or matching tests that were done before Phase 1.1 cutpoints were implemented. All records with either the roadside date or the Smog Check date before the implementation date of June 8, 1998, were deleted.

ERG divided the matching dataset into categories of Before Smog Check and After Smog Check. Vehicles that passed a Smog Check and then received a roadside test were defined as After Smog Check. Vehicles that received a roadside test before a Smog Check were designated Before Smog Check. Also, vehicles that failed a Smog Check then received a roadside were considered to be Before Smog Check, since the vehicle has not completed its testing cycle.

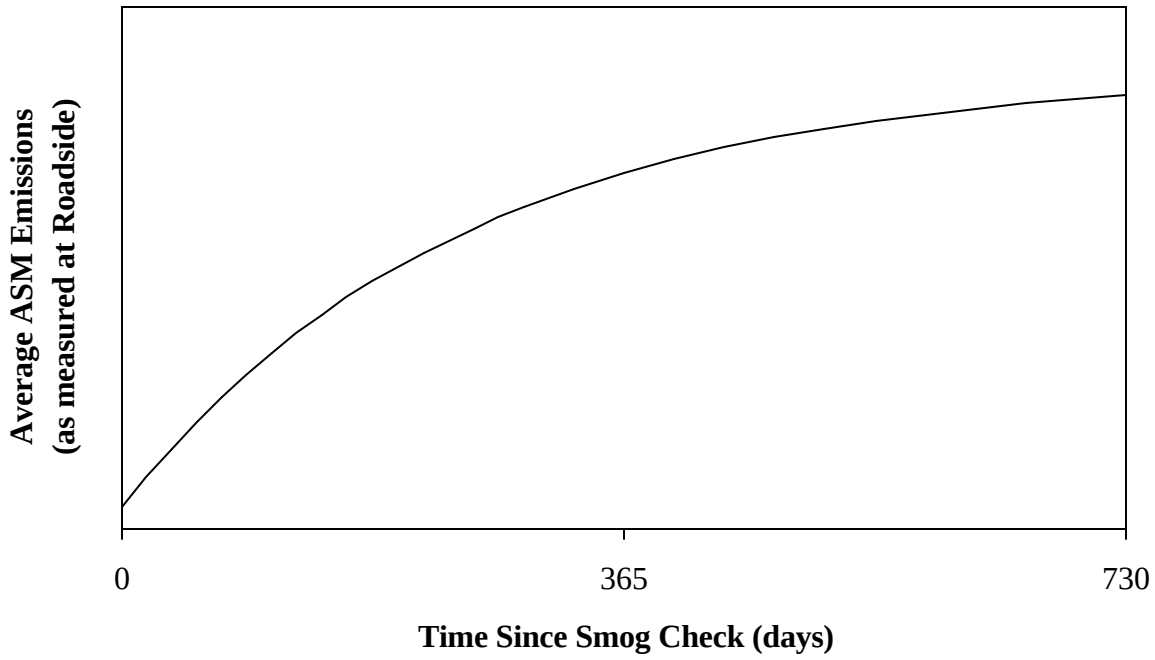
The matching dataset was also divided into categories based on the ranking of all stations. The station ranking was based on roadside test and data from the Vehicle Identification Database (VID). The station ranks used in this analysis were obtained from stnrank11.xls, which was originally produced on October 2, 2000. Each Smog Check station was matched with its rank and categorized as high performing or low performing.

# Appendix B

## Conceptual Description of Relationship Between Smog Check Station Types and Roadside Emissions

Conceptually, every vehicle's (roadside) emissions increase after its Smog Check inspection and repair. When the next Smog Check occurs, the (roadside) emissions should jog down to a lower value, and the cycle will repeat. For some vehicles that have properly operating emission control systems, emissions stay the same or go up only slightly during the two-year period. These vehicles would not get a repair at Smog Check, so no downward jog in emissions would occur for these vehicles. For vehicles that have a malfunction during the period, emissions go up abruptly. Ideally, these vehicles would be flagged for repair by the Smog Check. Consequently, their emissions would show a large downward jog following Smog Check inspection and repair. For the fleet as a whole, emissions would go up smoothly as shown in Figure B-1. Then, at the time of the next Smog Check, the fleet average emissions would jog down.

**Figure B-1. Fleet Average Expected Emissions Following Smog Check**




The data we are analyzing in this study is made up of a set of roadside ASM measurements matched with the last Smog Check ASM results for each vehicle. For a given vehicle, the roadside measurement occurs at any time in the vehicle's I/M cycle. Thus, we don't have measures of emissions of each vehicle throughout the I/M cycle; we have only a single point (a snapshot) of the emissions vs. Time Since Smog Check curve for each vehicle. However, we do have such snapshots of many vehicles at different points along the curve. Since vehicles were selected for roadside testing without regard to the date of their Smog Check, the

data will be distributed relatively evenly along the curve in Figure A-1. Consequently, if we use each vehicle's snapshot as an indicator of the fleet trend, it should be possible to evaluate the effect of Smog Check on fleet emissions. That is, we assume that we can infer the response of the fleet as a whole to the Smog Check program by examining the individual vehicle emissions snapshots.

Since Smog Check inspection/repair events occur throughout the year, the fleet emissions are more or less constant throughout the year. The estimate of the fleet average emissions is just the average value of the instantaneous emissions along the curve in Figure B-1. The shape of the curve and the size of the downward jog both affect this fleet average emissions value. Figure B-2 shows two different Smog Check performance behaviors. These could be for two different stations. The size of the downward jog associated with Smog Check inspection and repair is the same for both stations since the average emissions is the same for both stations at 0 days and at 730 days. However, the shapes of the curves indicate that the repairs performed at Station X are much more durable than those at Station Y. As a consequence, the annual average emissions of vehicles tested and repaired at Station X (Xavg) is much lower than the average emissions of vehicles tested and repaired at Station Y (Yavg). This example indicates that repair durability and immediate repair emissions benefit both affect fleet emissions.

In this study, we are primarily interested in the Smog Check emissions benefits produced by GSGR stations compared with the other stations. This includes the effect of the size of the downward emissions jog at Smog Check and the shape of performance curve. If no complications were present, we would just need to produce Figure B-3 from Figure B-1 by assigning each vehicle's snapshot to either GSGR, TO, Regular T&R, or GPC. For the hypothetical data in Figure B-3, the size of the downward jogs are largest for Station Type A and smallest for D. The shapes of the performance curves are all similar. Thus, Type A would be declared most effective at reducing emissions at the time of the Smog Check inspection repair.

**Figure B-2. Examples of Emissions Degradation Following Smog Check**

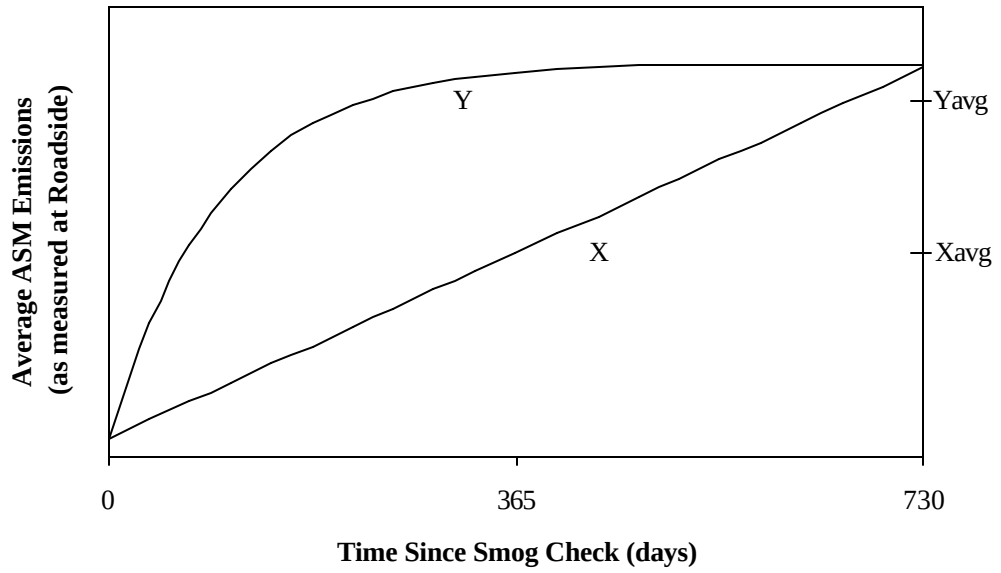
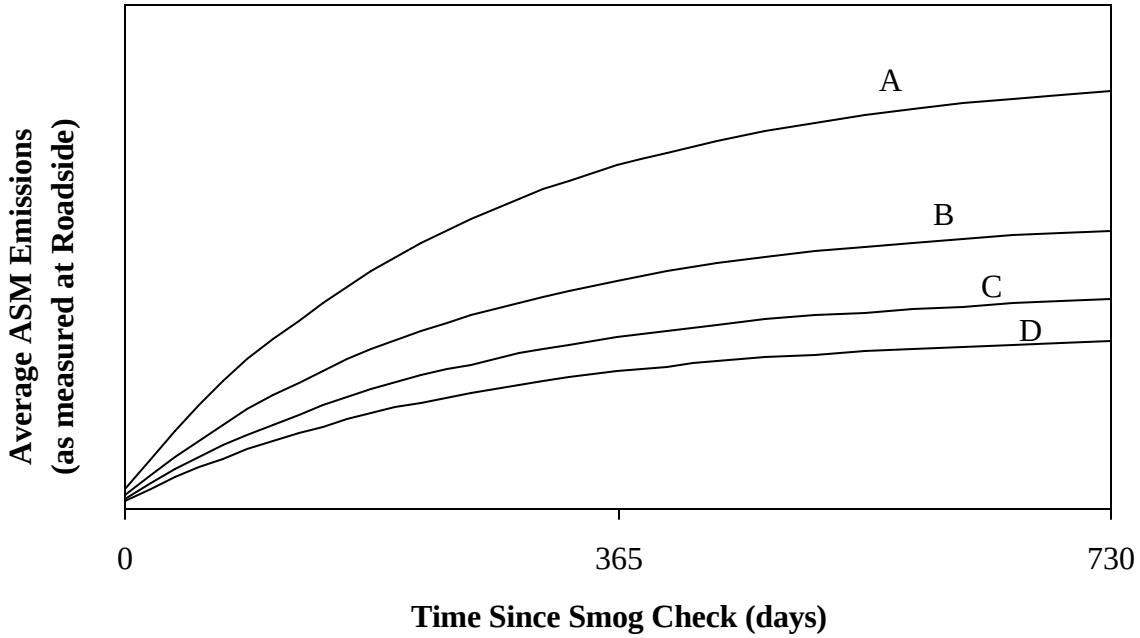



**Figure B-3. Examples of Emissions Degradation for Different Smog Check Stations**




However, with the dataset to be analyzed, there are a number of complicating factors. These factors cause the roadside emissions snapshot data points of individual vehicles to be dispersed from the Time Since Smog Check trend line of Figure B-1. If the effects of these

factors on the average emissions of the different station types are ignored, the emissions reductions assigned to different station types are likely to be incorrect. The following is a list of the different types of factors that can affect the analysis of station type effects:

1. Type of Smog Check station - This is the variable that we are interested in quantifying.

2. Specific Smog Check station - Obviously, not all stations of the same type have the same performance. Each station type will have a distribution of performances for its member stations. This distribution contributes to differences in roadside emissions. The analysis also needs to be aware that a subset of all Smog Check stations are represented by the vehicles that received roadside measurements.

3. Characteristics of Each Station's Operating Environment - Even if a station is a top-performing station for its type, each must operate in an environment which it has no or little control over. Failure to correct for these environmental factors can result in misjudging a station's performance or a station type's performance. Examples of environmental factors include:

   Model year distribution of vehicles coming to the station
   Average model year of vehicles coming to the station
   Cultural and maintenance habits of owners of vehicles coming to the station

4. Generic vehicle characteristics - A given vehicle will have a tendency to have emissions behavior similar to other vehicles of the same description. Generic vehicle characteristics include:

   Model year
   ASM Fprob
   Vehicle type (car vs. truck)

5. Individual vehicle characteristics - An individual vehicle will differ from vehicles of the same generic description in many ways. These individual vehicle characteristics can cause the roadside emissions to be very different from their peers. They include:

   Odometer
   Repairs performed in previous I/M cycles
   Vehicle age

   However, we expect that to a large degree, the final Smog Check emissions measurement prior to the roadside measurement will take into account the historical effects of odometer and previous repairs.

6. Differences between Roadside measurement and Smog Check measurement - We assume that there are no measurement procedure differences between Roadside and Smog Check or at least that there is a consistent difference between the two. Then, the only other difference is the time elapsed between the two measurements. Long times from previous

Smog Check to Roadside measurements give more opportunity for vehicles to deteriorate than short times do.

7. Cutpoint differences - The matched dataset covers a period of about three years. During this period the cutpoints applied to vehicles have been becoming more stringent. As this has been happening, we should expect that final emissions are coming down and fail rates are increasing. Any analysis that bridges more than a single cutpoint phase needs to take into account changing cutpoints.

# Appendix C

## Model of Emission Reductions for Characteristics of the Roadside Vehicle Sample

There are several factors that complicate the estimation of emissions reduction by station type. In the traditional analysis only model year group was used to account for differences in vehicle distributions among the four station types. We have also attempted to account for the other factors in estimating the emission reductions. We considered the influences of the variables available in the dataset:

- Roadside emissions reductions for GPC stations (%)
- Roadside emissions reductions for GSGR stations (%)
- Roadside emissions reductions for Regular T&R stations (%)
- Roadside emissions reductions for TO stations (%)
- Fprob of the emission being evaluated
- Vehicle model year
- Vehicle Type (car, truck)
- Odometer (miles),
- Each station's historical average model year of vehicles inspected
- Cutpoint phase
- Time since the Smog Check that roadside measurements were made

In accounting for these affects first we must determine which of these variables has the largest influences on the six types of ASM emissions. An analysis of variance indicates that the Fprob of the emission being evaluated had the greatest effect on emissions. Together, Fprob and model year explained about 24%, 13%, and 24% of the variability of the roadside ASM HC, CO, and NO emissions, respectively. Odometer, vehicle type, and average model year at the station explained smaller parts of the variability in the roadside emissions. Cutpoint phase and time since the Smog Check that roadside measurements were made had small effects; they were dropped from further consideration.

Second, we modeled the effects of the variables that affected the roadside emissions so that the effects of the stations on emissions reductions could be quantified independent of the other variables. We built linear models to predict the natural log of each of the six roadside ASM emissions with the SAS PROC REG stepwise procedure that selected the most important main effects and higher order interactions of the following variables:

- Roadside emissions reductions for GPC stations (%),
- Roadside emissions reductions for GSGR stations (%),
- Roadside emissions reductions for Regular T&R stations (%),
- Roadside emissions reductions for TO stations (%),
- Fprob of the emission being evaluated,
- Vehicle model year,
- Vehicle type (car, truck), and
- Each station's historical average model year of vehicles inspected.

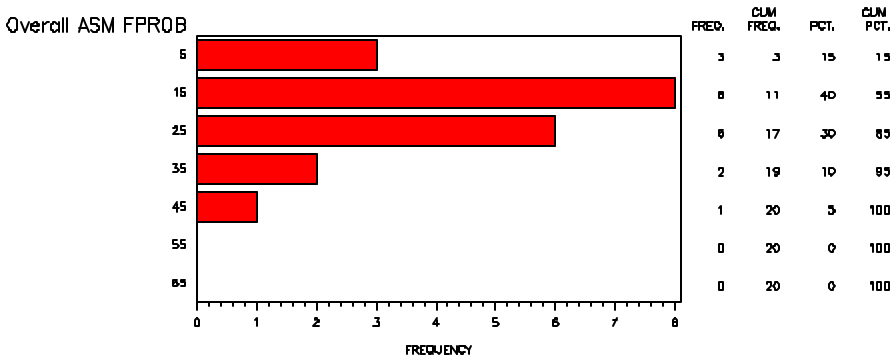
Even though Odometer was found to have a significant effect on emissions in the variance analysis, it was not used in the modeling since it is known to have a large fraction of inaccurate values in the VID.

The models showed that all six ASM emissions increase with Fprob and trucks and decrease with newer model year vehicles and stations that inspect newer vehicles. These trends confirm that these factors do have an impact on the estimation of emission reductions by station type.

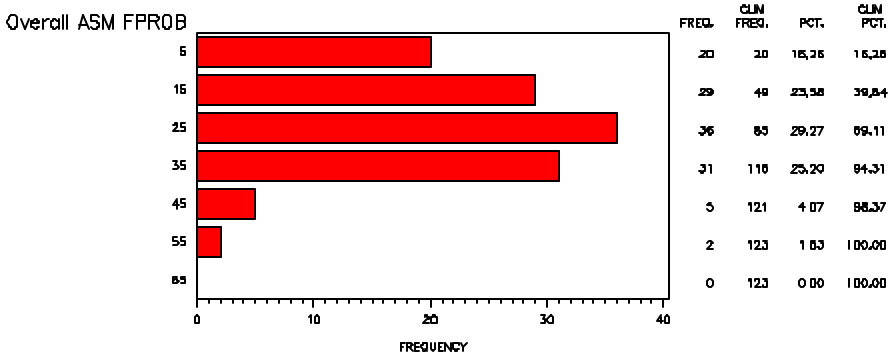
# Appendix D

## Overall ASM Fprob Distributions by Station Type and Model Year Group

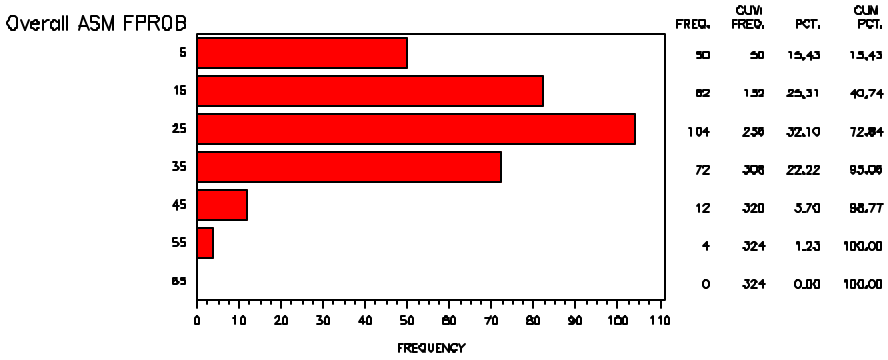
Model Year Group = 1973 – 1979  Station Type = GPC



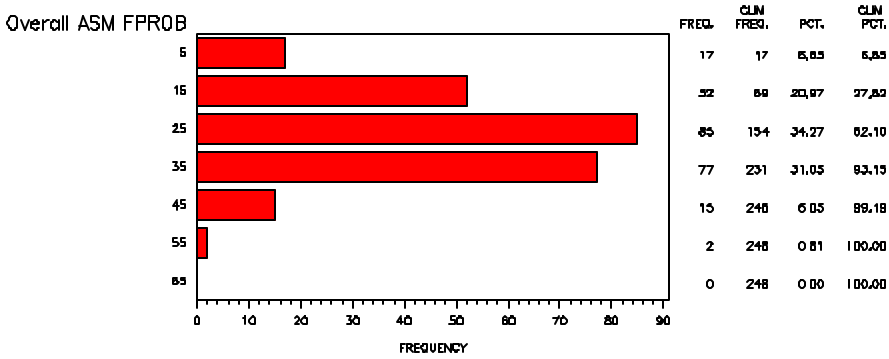

Model Year Group = 1973 – 1979  Station Type = GSR



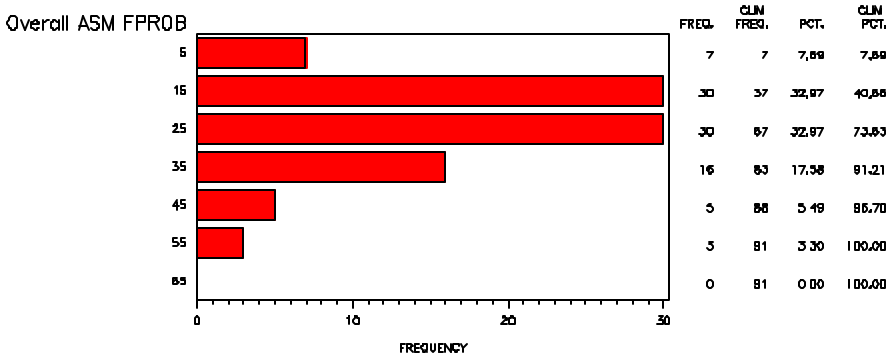
Model Year Group = 1973 – 1979 Station Type = TR




Model Year Group = 1973 – 1979 Station Type = TQ

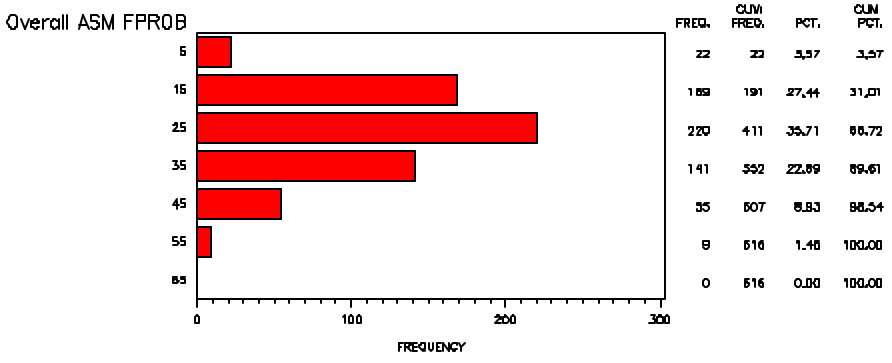


Model Year Group = 1980 – 1986 Station Type = GPC



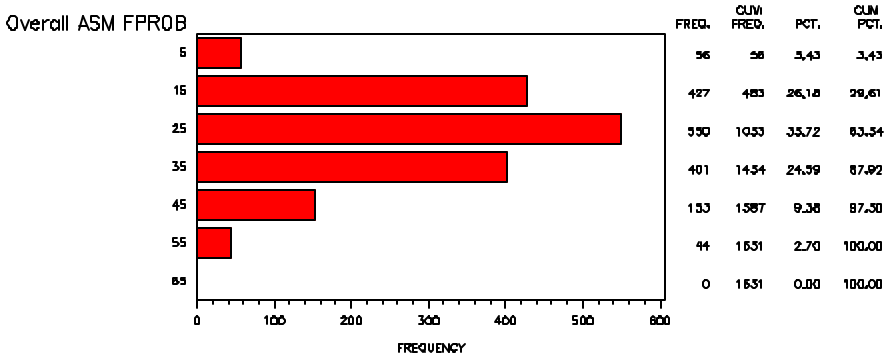

| | FREQ. | CUM FREQ. | PCT. | CUM PCT. |
|---|---|---|---|---|
| 5 | 7 | 7 | 7.69 | 7.69 |
| 15 | 30 | 37 | 32.97 | 40.66 |
| 25 | 30 | 67 | 32.97 | 73.63 |
| 35 | 16 | 83 | 17.58 | 91.21 |
| 45 | 5 | 88 | 5.49 | 96.70 |
| 55 | 3 | 91 | 3.30 | 100.00 |
| 65 | 0 | 91 | 0.00 | 100.00 |

Model Year Group = 1980 – 1986 Station Type = GSR

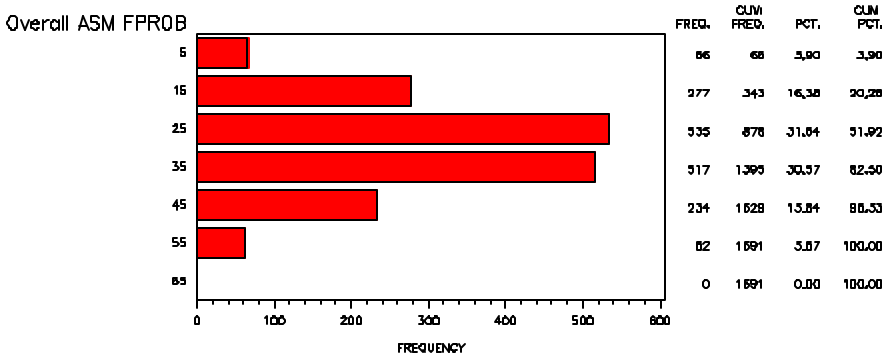



| | FREQ. | CUM FREQ. | PCT. | CUM PCT. |
|---|---|---|---|---|
| 5 | 22 | 22 | 3.57 | 3.57 |
| 15 | 169 | 191 | 27.44 | 31.01 |
| 25 | 220 | 411 | 35.71 | 66.72 |
| 35 | 141 | 552 | 22.89 | 89.61 |
| 45 | 55 | 607 | 8.93 | 98.54 |
| 55 | 9 | 616 | 1.46 | 100.00 |
| 65 | 0 | 616 | 0.00 | 100.00 |

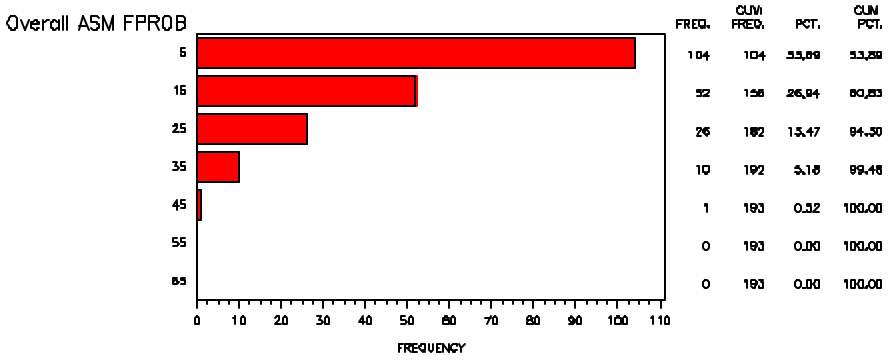
Model Year Group = 1980 – 1986 Station Type = TR



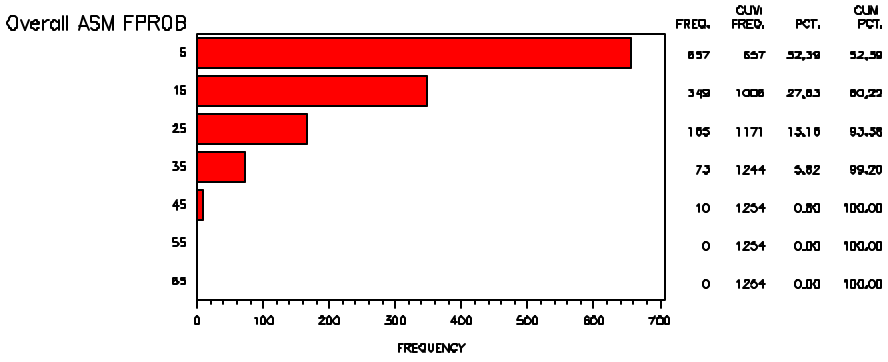

Model Year Group = 1980 – 1986 Station Type = TQ



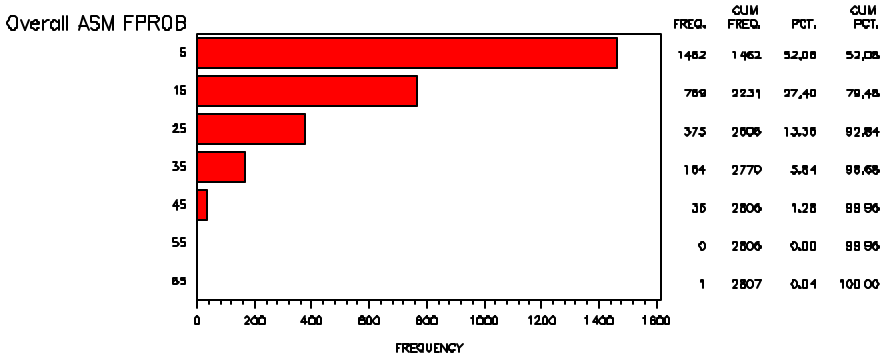
Model Year Group = 1987 – 1991  Station Type = GPC



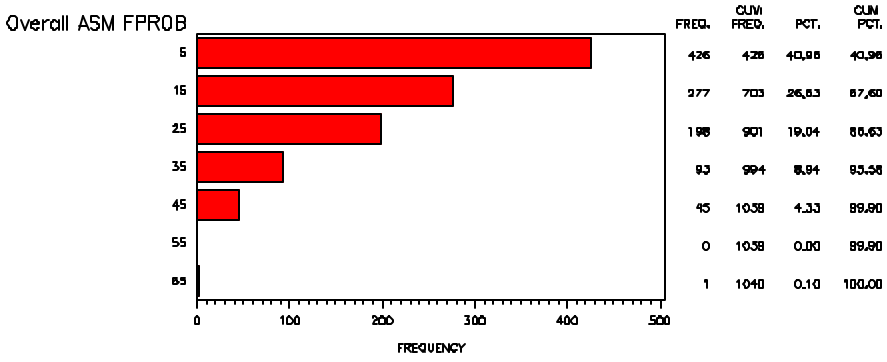

Model Year Group = 1987 – 1991  Station Type = GSR



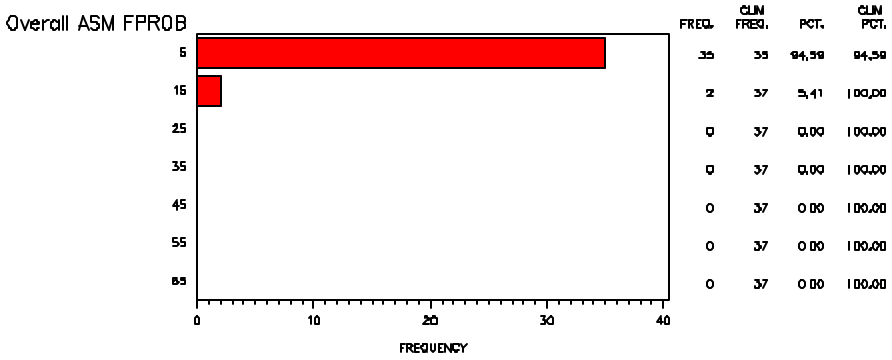
Model Year Group = 1987 – 1991  Station Type = TR



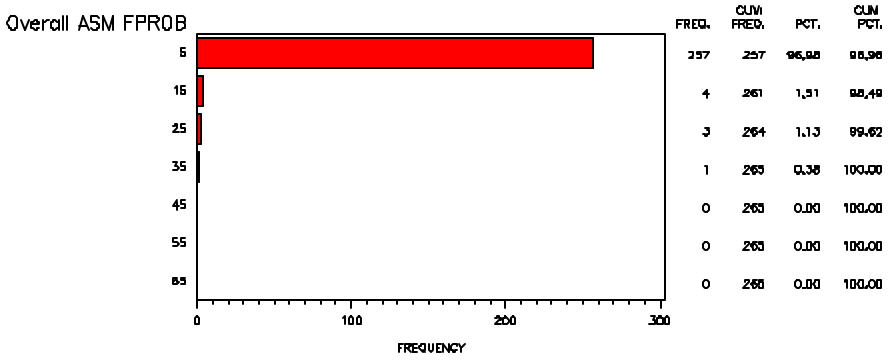

Model Year Group = 1987 – 1991  Station Type = TQ



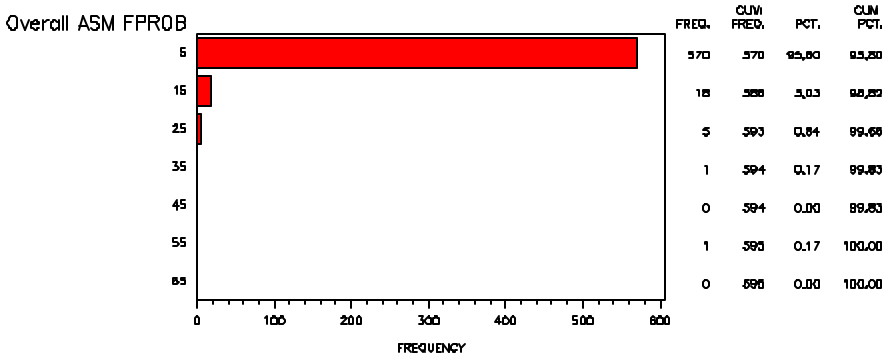
Model Year Group = 1992 – 1999 Station Type = GPC




Model Year Group = 1992 – 1999 Station Type = GSR



Model Year Group = 1992 – 1999 Station Type = TR




Model Year Group = 1992 – 1999 Station Type = TQ